Remarks

In the final Office action of October 10, 2008, claims 10-14 were objected to under 37 CFR 1.75(c) as being of improper dependent form. In particular, claims 10-14 merely recited an intended use for the method in independent claim 1 and, therefore, failed to further limit the subject matter either by reciting an additional step or further refining a scope of a particular, preexisting step in the parent claim. Accordingly, applicant amends claims 10-14 to further define the particular type of network upon which the method operates and to further refine the managing step of claim 1. The objection is believed to be traversed.

Additionally, applicant amends the claim set to further improve clarity and definiteness of the claimed subject matter. In particular, claim 1 is amended to remove certain inconsistencies and grammatical errors. The step of "grouping the nodes into regions surrounding each identified centre node" has been replaced because the "grouping" is actually the result of assigning region membership to certain nodes, as specified by the role assignment step. The "grouping" step therefore did not represent any real limitation separate from the role assignment, and thus made the claim difficult to interpret properly. In the amended claim 1, this is now specified by a step of "defining one region for each centre node by assigning a role of region member nodes in a given region to all nodes for which a steepest ascent link path in the topology terminates uniquely at the centre node of that region". Thus the step of assigning the role of region member has been made more concise and clearly the basis for defining the regions.

Also in claim 1, assigning the roles of border nodes, bridge nodes and dangler nodes has been removed as

unnecessary for the definition in claim 1, inasmuch as no other step in this claim relies on these roles (as opposed to reliance on the number of regions - obtained by identifying the centre nodes - and on the size of regions - obtained by assigning the role of region members). Additionally, criteria for assigning the roles of border nodes, bridge nodes and dangler nodes were not specified in claim 1. The roles of border, bridge and dangler nodes are now defined in dependent claims 6-8.

Also in claim 1, the preamble replaces "determining" with "managing", and in the final step "measuring" is replaced with "managing", to make the terminology consistent throughout the claim. The "managing" of networks has a clear basis in the description on page 32, lines 7-11 and page 27, lines 8-13.

Amended claim 2 recites "media types" instead of "types of bonds" to be consistent with the antecedent terminology used in the specification, e.g. on page 10, lines 1-13; page 11, line 34; and page 19, line 20. The same applies to amended claim 4.

Claims 16 and 17 are new. Support for claim 16 is found on page 14, lines 21-27 (paragraph [0079] in the published application) and on page 19, lines 14-18 (paragraph [0108]). Support for claim 17 is found on page 19, lnes 19-23 (paragraph [0109]).

Claims 18-22 are new and define the subject matter in more specific ways, as seen by independent claim 18.

<u>The Obviousness Rejection</u>

Claims 1-15 were rejected under 35 USC 103(a) as being unpatentable over the printed publications of Girvan et al., Borgatti, Cheng, and Hanneman. (See Office action, bottom of page 6, for further identification of the cited

publications.) Applicant takes notice of the Examiner's rebuttal (Office action, pages 3-6) of the previously submitted arguments. Nevertheless, applicant respectfully disagrees with the conclusion of obviousness for the following reasons. The amended set of claims is asserted to be patentable over the cited prior art.

(i) Girvan et al.

Girvan describes a method for detecting "community structure" in networked systems where network nodes are joined together in tightly knit groups, between which there are only looser connections. Girvan's method is built around the idea of using centrality indices to find community boundaries. (Girvan, Abstract) Girvan discusses shortcomings of traditional methods (hierarchical clustering) that calculate weights $W_{i,j}$ for every pair i,j of vertices in the network and then add edges between those pairs of vertices that have no edges between them, the edges being added one-by-one in order of their weights starting with the pair with the strongest weight so as to construct a nested set of connected subsets of vertices, taken to be communities. Two different definitions of the weight are provided, based on the number of node-independent (or edge-independent) paths between vertices, or on the total number of paths between vertices (whether node or edge independent or not) weighted by a path length-dependent factor. (pp. 7821-22) As an alternative approach, Girvan proposes using a betweenness measure to focus on those edges that are least central (or most "between") communities, by progressively removing edges from the original graph. Edge betweenness is defined by Girvan as the number of shortest paths between pairs of vertices that run along that edge. If there is more than one shortest path between a pair of vertices, each path is given equal weight such that the total

weight of all of the paths is unity. Edges connecting communities will have high edge betweenness and by removing those edges they separate groups and reveal the underlying community structure.

Girvan does not teach any method for determining the ability of a network to spread information or physical traffic, but rather is solely concerned with detecting communities within a network. The abstract summarizes the Girvan article with: "In this article, we highlight another property that is found in many networks, the property of community structure, in which network nodes are joined together in tightly knit groups, between which there are only looser connections. We propose a method for detecting such communities, built around the idea of using centrality indices to find community boundaries." While Girvan detects membership of nodes in communities, the paper does not deal with either detecting or managing transport of information or physical traffic along the links that connect the various members of the detected communities. Thus, Girvan is clearly distinguished from the present claims where "managing the ability of a network to spread information in physical traffic" (claim 1) is of primary interest.

The Office action alleges incorrectly that Girvan teaches ". . .identifying nodes which are local maxima of the weights as centre nodes. . ." (Office action, page 7; citing Girvan, page 7822, "Edge 'Betweenness' and Community Structure" section, paragraph 2, and page 7824-7828, Figs. 4-6). Applicant respectfully disagrees with the allegation. The referenced section describes how edge betweenness is used for progressively removing most between (least central) edges in order to identify communities of nodes. There is nothing in the citation about identifying the local maxima of anything, even of "betweenness". At best, <u>global</u> maxima of

edge betweenness are identified for progressively pruning away certain edges. Girvan teaches away from using vertex betweenness, since it is edges rather than vertices that are being removed in the proposed method, and even if vertices were to be removed for some reason, Girvan teaches use of global maxima to identify those particular elements to be removed from the graph that models the network.

Girvan likewise teaches away from any node or path weights as in the prior art hierarchical clustering methods due to shortcomings noted in the paper, and thus also teaches away from identifying any centre nodes whether by weight or any other technique. Even the description of the prior clustering method does not use local maxima of the weights, but solely uses global maxima in order to progressively add edges to the network graph. Girvan (as well as the prior clustering methods that the paper discusses) finds communities of nodes by progressively removing (or adding) edges according to global maxima of a specified measure, but fails to teach or suggest identifying centre nodes of those communities. The Girvan technique focuses away from centre nodes, concentrating instead on community boundaries using their edge betweenness measure.

Applicant's claim 1 specifies that the values for which local maxima should be identified are Eigenvector Centrality indices that are computed based on link strength values. Girvan does not teach that any value, Eigenvector centrality index or otherwise, should be computed from link strengths (or edge weights). While Girvan does describe the traditional clustering methods that directly use vertex or edge weights to determine edges to be added to a network graph, no suggestion is made that any of these weights be used as a basis for computing centrality indices, nor that local maximum of such indices be used to identify centre nodes.

These features set forth in applicant's independent claim 1 are not provided in Girvan.

(ii) Borgatti

The Office action acknowledges the failure of Girvan to teach the computing of an Eigenvector Centrality index (Office action, bottom of page 7), but cites the paper of Borgatti for teaching computing of an Eigenvector Centrality index (Office action, page 8). Borgatti compares several measures for network analysis (degree centrality, closeness, betweenness, eigenvector centrality, etc.) and classifies them according to network flow topology (node-to-node transmission mechanism: parallel duplication, serial duplication, transfer; trajectory: geodesics, paths, trails, walks) in order to aid a user in choosing the most appropriate measure for the particular network. (Borgatti, Abstract: "Measures of centrality are then matched to the kinds of flows that they are appropriate for. . . It is shown that off-the-shelf formulas for centrality measures are fully applicable only for the specific flow processes they are designed for, and that where they are applied to other flow processes they get the 'wrong'answer.")

Borgatti fails to disclose use of the Eigenvector centrality index to identify centre nodes by means of local maxima, nor assigning a role of region member nodes by means of steepest ascent link path. Indeed, beyond simply characterizing eigenvector centrality as being appropriate for parallel duplication node-to-node transmission and walk-type trajectories, there is no description of the particular steps that the present claimed method does with the Eigenvector Centrality index. Even if the Borgatti mention of eigenvector centrality as an appropriate centrality measure in some network analysis contexts were somehow to be applied to

Girvan, the combination would not reach the claimed features of identifying or assigning a role of centre nodes and region member nodes based on local maxima and steepest ascent paths of the computed Eigenvector Centrality indices. At best, eigenvector centrality in Borgatti might substitute for the weights used in the prior clustering technique described by Girvan, using the eigenvector centrality measure as a basis for progressively adding edges to a network graph to identify communities. This is not the present claimed invention, and in any case Girvan teaches away from the clustering technique, using betweenness as a measure for removing edges, again to identify communities, not to define roles.

(iii) Cheng

It was correctly pointed out by the Examiner (Office Action, page 8) that Borgatti does not teach that region members are assigned based on a steepest ascent link path terminating at a unique centre node, as set forth in applicant's claim 1. However, the Office action cites Cheng (Office Action, page 8; also Office Action, page 4), asserting that it shows creating groups based on a gradient ascent to the nearest maxima. Applicant respectfully disagrees with that assertion. Cheng describes mean shift clustering, which is based on shifting data points to the average of data points in it neighborhood. The gradient that Cheng uses for the shifting is a gradient of the density function of the kernel (discussed in Cheng's reference [1]). Cheng's mean shift clustering has nothing whatsoever to do with finding a steepest link path to a center node or with the Eigenvector centrality measures employed in the present claims.

(iv) Hanneman

The Office action correctly notes that neither Girvan, nor Borgatti, nor Cheng teach assigning roles of bridge nodes and dangler nodes (Office Action, page 8), but cites Hanneman (page 77, paragraph 3; page 40, paragraph 2) for teaching bridges and sinks (dangling nodes) in networks. (Office Action, bottom of page 8). Applicant replies that while Hanneman does show that bridges and sinks are known in graph theory, the document fails to disclose Applicant's claimed method using steepest ascent link paths for identifying certain nodes as bridges and danglers, per the criteria set forth in claims 7 and 8. Thus, Hanneman does not cure the deficiencies in the teachings of Girvan with Borgatti and Cheng.

Dependent Claims

Those claims dependent upon claim 1 are asserted to be patentable for the reasons given above for independent claim 1 and recite additional details not found in the cited art. Claims 7 and 8 have been discussed in relation to Hanneman. Regarding claims 2-4, while Borgatti mentions eigenvector centrality as one of several measures it compares for network analysis, the particular modes of computing link strength that will be the basis for the eigenvector centrality measure are not described. None of the citations take account of differences of media types supported by the different links. In the citations, a link is either present or absent between two nodes or vertices. Especially with regard to claim 4, none of the citations teach computing link strengths based on normalized fractions of the amount of traffic for each of the supported media types in a link. Thus, claims 2-4 and 7-8 have patentability for reasons that go beyond that for claim 1 generally.

Conclusion

Applicant requests reconsideration of the claims in view of the amendments and remarks presented herein. The amended claims and newly presented claims are asserted to be patentable for the reasons given. A Notice of Allowance is earnestly solicited.

Respectfully submitted,

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CERTIFICATE OF TRANSMISSION

I hereby certify that this paper (along with any paper referred to as being attached or enclosed) is being transmitted via the Office electronic filing system in accordance with § 1.6(a)(4) on the date shown below.

Signed: Merle P. Garcia
Typed Name: Merle P. Garcia

Date: April 9, 2009